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# RESISTANCE TO APHIDS, MITES, AND THRIPS IN FIELD BEANS RELATIVE TO INFECTION BY APHID-BORNE VIRUSES

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The green peach aphid (*Myzus persicae* (Sulzer)), the pea aphid (*Acyrthosiphon pisum* (Harris)), and several other species of aphids transmit strains of bean common mosaic virus (BCMV), bean yellow mosaic virus (BYMV), and alfalfa mosaic virus (AMV), all of which cause damage to beans (*Phaseolus vulgaris* L.) (5).[2] Also, the twospotted spider mite (*Tetranychus urticae* Koch) and the onion thrips (*Thrips tabaci* Lindeman) are pests of field beans in eastern Washington. In some instances, insecticides can control these pest insects, but usually the action is not rapid enough to prevent the transmission of virus or direct injury, as in the case of mites (2).

Resistance to virus based on reaction to mechanical inoculation has been reported for many bean varieties (5). However, bean virus diseases can also be controlled by the selection and breeding of plant material that is resistant to the insect vectors (1, 3); for example, Robertson and Klostermeyer (4) found that the green peach aphid preferred 'Red Mexican UI-34' to four other bean varieties. Furthermore, when certain bean selections that were highly susceptible to infection with mosaic viruses were mechanically inoculated in the greenhouse, they had a low incidence in the field.

This study was made to determine the resistance to aphids among bean selections differing in the field incidence of two aphid-borne virus diseases. The selections were also evaluated for resistance to mites and thrips. Since aphid populations in field plots were too scarce for any definite determinations in 1967-69, only data for 1965 and 1966 are included here.[3]

## METHODS AND MATERIALS

In 1965, 30 bean varieties were each planted in 25-foot-long single-row plots (4 replicates) at two locations and maintained weedfree. After all plants had emerged, alate and apterous aphids of all species were counted on 25 trifoliate leaves removed from each plot at both locations on June 10 and 25 and July 14 and 28. Also, the mites on 2-cm. disks from 25 leaflets were counted under a binocular microscope on July 29 and August 11.

In 1966, three plantings of 16 bean varieties each were made in plots four rows wide and 15 feet long (4 replicates), one at Prosser and two at Yakima, Wash. Populations of aphids, mites, and thrips were determined by collecting 25 trifoliate leaves from each plot of the three plantings and counting the aphids on July 11, 20, August 4, and 17, the mites on August 17 and September 6, and the thrips on August 3, 10, and 17.

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[1] In cooperation with the Washington State University.

[2] Numbers in parentheses refer to Literature Cited at the end of this report.

[3] Although the data on which this report is based were collected during 1965-69, the findings are still valid and useful as guidelines for developing additional research.

## RESULTS AND DISCUSSION

The populations of aphids were lower in 1965 than in 1966, but they were large enough so we could establish differences in infestations among plots. The green peach aphid constituted about 80 percent of the population, and 10 percent were pea aphids; the other 10 percent included potato aphids *(Macrosiphum euphorbiae* (Thomas)), English grain aphids (*Macrosiphum avenae* (F.)), bean aphids *(Aphis fabae* Scopoli), and the so-called leaf-curl plum aphid *Brachycaudus helichrysi* (Kaltenbach). Alate aphids averaged 10 to 15 percent and apterous aphids 85 to 90 percent of the total population infesting beans in the field plots.

Also in 1965, infestations of the twospotted spider mite were below normal, but there was some evidence of resistance among the test varieties (table 1). For example, 'Red Mexican UI-35' and 'Black Turtle Soup' had intermediate resistance to mites. However, the bean varieties with the greatest number of aphids were not always the varieties that had the greatest number of mites. Thus correlation between resistance to aphids and to mites was not consistent.

The bean selections planted in 1966 were considered to represent the range of resistance to aphids observed in 1965. The July 11 count showed 527 alate (28 percent) and 3,034 apterous aphids (72 percent); 95 percent were the green peach aphid and the other species included the pea aphid, the English grain aphid, the bean aphid, and the so-called leaf-curl plum aphid. The July 20 count showed 601 (13 percent) alate and 3,945 (87 percent) apterous aphids; again, 95 percent were the green peach aphid. By the time of the August 4 count, the bean plants had begun to mature and the aphid populations were declining: 221 (6 percent) were alate and 3,365 (94 percent) were apterous aphids. Almost all were the green peach aphid.

Resistance to aphids among the bean selections

TABLE 1.—*Aphids and mites on 30 bean varieties in field test plots, 1965*

| Bean variety | Aphids[1] | | Mites[2] | |
|---|---|---|---|---|
| | Average of 4 counts | Rank | Average of 2 counts | Rank |
| Red Mexican UI-37 | 828 a | 30 | 156 | 17 |
| Great Northern 1140 | 822 ab | 29 | 220 | 23 |
| Red Mexican UI-34 | 818 abc | 28 | 157 | 19 |
| Tenderwhite | 712 abcd | 27 | 535 | 30 |
| Red Mexican UI-36 | 631 abcd | 26 | 139 | 16 |
| Red Mexican UI-35 | 618 abcde | 25 | 136 | 15 |
| Flat Small White | 567 bcdef | 24 | 58 | 6 |
| Charlevaix | 524 cdef | 23 | 238 | 24 |
| Red Mexican UI-1 (Bigbend) | 507 cdef | 22 | 465 | 29 |
| Yakima | 485 cdef | 21 | 173 | 21 |
| Large Red Kidney 272 (USDA breeding line) | 484 cdef | 20 | 79 | 8 |
| Bountiful | 479 defg | 19 | 106 | 9 |
| Slimgreen | 474 defg | 18 | 34 | 3 |
| Puregold | 448 defg | 17 | 204 | 22 |
| California Dark Red Kidney | 421 defg | 16 | 135 | 14 |
| Romano | 420 defg | 15 | 391 | 27 |
| Great Northern UI-31 | 416 defg | 14 | 44 | 4 |
| Red Mexican UI-2 (Coulee) | 385 defg | 13 | 158 | 20 |
| Kinghorn | 376 efg | 12 | 457 | 28 |
| Gallatin 50 | 364 efg | 11 | 119 | 12 |
| Sutter Pink | 332 fg | 10 | 350 | 26 |
| Dark Red Kidney | 326 fg | 9 | 74 | 7 |
| Dana Pinto | 303 g | 8 | 298 | 25 |
| Red Mexican 6 (USDA breeding line) | 286 g | 7 | 120 | 13 |
| California Small Flat White | 283 gh | 6 | 109 | 10 |
| Columbia Pinto | 234 gh | 5 | 114 | 11 |
| Pinto UI-111 | 196 ghi | 4 | 53 | 5 |
| Pinto UI-114 | 162 hi | 3 | 22 | 1 |
| Great Northern UI-123 | 153 hi | 2 | 34 | 2 |
| Black Turtle Soup | 134 i | 1 | 156 | 18 |

[1] Averages followed by same letters are not significantly different at 5-percent level of probability by Duncan's multiple-range test. [2] Not significantly different.

was similar in both years (tables 1 and 2). Black Turtle Soup, which was the most resistant, seldom shows symptoms of aphid-borne mosaic diseases in the field though it is highly sensitive to mechanical inoculation with the common strains of BYMV and AMV. 'Red Mexican 6,' which had intermediate resistance to aphids, is highly susceptible to mechanical inoculations of the New York 15 strain of BCMV, but it has symptoms of the common mosaic diseases in the field less often than 'Red Mexican UI-34.'

With the data obtained from the field tests in 1965 and 1966, we were able to establish five separate types of reactions as follows:

| *Type* | *Reaction* |
|---|---|
| I . . . . . . | Highly susceptible (no physiological resistance) to BYMV and BCMV transmitted by aphids or mechanically inoculated; not resistant to aphids. |
| II . . . . . . | Physiological resistance to both viruses by either method of transmission but not resistant to aphids. |
| III . . . . . | Highly susceptible to BYMV by either method of inoculation, but physiologically resistant to BCMV; intermediate in resistance to aphids. |
| IV . . . . . | Physiologically resistant to both viruses by either method of inoculation; intermediate in resistance to aphids. |
| V . . . . . | Susceptible to BYMV by mechanical inoculation but resistant to aphids. |

The five cultivars in table 3 were selected from the cultivars and breeding lines tested in 1965 and 1966 as representative of the five types of reaction. They ranged in resistance to aphids from Black Turtle Soup (most resistant) to Red Mexican UI-34 (least resistant), and their relative positions were consistent in this respect in both test years. Also, they were known to vary in their reactions to BYMV and BCMV, depending on the type of inoculation.

These differential reactions to method of inoculation show that two kinds of resistance are available in beans. Black Turtle Soup, which supported the fewest aphids, rarely shows symptoms of disease in the field, despite conditions that cause susceptible varieties like Red Mexican UI-34 to show a high percentage of infection with these two aphid-borne viruses. On the other hand, Black Turtle Soup is susceptible to BYMV by mechanical inoculation as is Red Mexican UI-34.

We therefore believe that the field resistance to BYMV shown by Black Turtle Soup results from resistance to aphids. We do not know, on the basis of present information, whether the resistance causes a change in the alighting, resting, probing, feeding, or reproductive response or possibly a change in several responses.

In contrast, Red Mexican UI-35 is resistant to both viruses in the field, but unlike Black Turtle Soup, it is also resistant to mechanical inoculation. Then, since there is little difference between Red Mexican UI-34 and Red Mexican UI-35 in attractiveness to aphids in bean fields, the resistance of Red Mexican UI-35 to

TABLE 2.—*Aphids, mites, and thrips on 16 bean varieties in field test plots, 1966*

| Bean variety | Aphids[1] | | Mites[2] | | Thrips[2] | |
|---|---|---|---|---|---|---|
| | Average of 4 counts | Rank | Average of 2 counts | Rank | Average of 3 counts | Rank |
| Tenderwhite | 1,552 a | 16 | 596 | 16 | 726 | 16 |
| Red Mexican UI-34 | 1,368 ab | 15 | 120 | 9 | 556 | 11 |
| Red Mexican UI-35 | 1,343 ab | 14 | 38 | 1 | 453 | 8 |
| Red Mexican UI-36 | 1,231 abc | 13 | 57 | 3 | 444 | 7 |
| Bountiful | 910 bcd | 12 | 344 | 15 | 699 | 14 |
| Romano | 827 bcd | 11 | 268 | 14 | 483 | 10 |
| Red Mexican, Bigbend | 742 cde | 10 | 62 | 4 | 423 | 6 |
| Red Mexican 6 (USDA breeding line) | 674 cde | 9 | 69 | 5 | 411 | 5 |
| Yakima | 496 de | 8 | 146 | 10 | 571 | 12 |
| Great Northern UI-31 | 489 de | 7 | 189 | 11 | 626 | 13 |
| Pinto UI-114 | 406 de | 6 | 44 | 2 | 410 | 4 |
| Great Northern UI-123 | 405 de | 5 | 216 | 12 | 467 | 9 |
| Columbia Pinto | 400 de | 4 | 113 | 8 | 722 | 15 |
| Puregold | 373 de | 3 | 216 | 13 | 398 | 3 |
| Great Northern 1140 | 310 de | 2 | 109 | 7 | 362 | 1 |
| Black Turtle Soup | 167 e | 1 | 69 | 6 | 395 | 2 |

[1] Averages followed by same letters are not significantly different at 5-percent level of probability by Duncan's Multiple-range test. [2] Not significantly different.

TABLE 3.—*Types of reaction observed among 5 field bean cultivars exposed to natural (aphid) and artificial (mechanical) inoculation of 2 aphid-borne virus diseases and to natural infestations of aphids*

| Type of reaction[1] | Susceptibility[2] to— | | | | | Cultivar (example) |
|---|---|---|---|---|---|---|
| | BYMV | | BCMV | | Aphids | |
| | Natural inoculation | Artificial inoculation | Natural inoculation | Artificial inoculation | | |
| I | S | S | S | S | S | Red Mexican UI-34. |
| II | R | R | R | R | S | Red Mexican UI-35. |
| III | S | S | R | R | I | Yakima. |
| IV | R | R | R | R | I | Great Northern UI-31. |
| V | R | S | R | R | R' | Black Turtle Soup. |

[1] See text for definition of reactions. [2] S = susceptible; R = resistant; I = intermediate.

disease must result from physiological resistance to the virus. Red Mexican UI-35 also had resistance to the twospotted spider mite (table 2), and the senior author has observed less infestation by the twospotted spider mite in Red Mexican UI-35 than in other Red Mexican varieties in bean fields.

'Great Northern UI-123' seems to possess both kinds of resistance—intermediate resistance to aphids and mites and physiological resistance to both viruses by mechanical inoculation.

The variety 'Yakima' was included in table 3 to demonstrate that physiological resistance to BCMV is independent of physiological resistance to BYMV. Yakima is intermediate in resistance to aphids and is susceptible to BYMV by either method of inoculation.

On the basis of our findings, we suggest that plant breeders make an effort to incorporate both kinds of resistance into breeding programs for the development of new bean varieties.

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